ME 450 Section 2 Winter 2008

# Shape Memory Alloy Automotive Sunscreen
# Final Report

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# I. Executive Summary

Temperatures within a car can reach as high as 110°C, so a method of keeping the interior cool is necessary. Sunscreens are an effective method, but many of the current screens do not meet the needs of most segments of the car market. Presently, sunscreens come in two varieties: those that are manually operated and those that are motor operated. The manually operated sunscreens can be awkward to deploy for a driver, as they require the driver to physically walk to the screen from the driver's seat. While the motorized screens deploy easily, the DC motor that runs the system is relatively heavy, and takes a lot of storage space. Furthermore, in order for the motor to operate quietly it must be well lubricated, which increases the cost of this system.

For this reason, General Motors Corporation had sponsored the development of an automatically deployed sunscreen that uses shape memory alloys (SMA) to allow for quieter deployment of the screen as well as a smaller packaging volume than current motor driven screens. Using an SMA to drive the sunscreen will allow the mechanism to weigh less, have a smaller packaging volume, and deploy quietly. Specifications were laid out during a January 17$^{th}$ meeting with the project sponsor, and included user activation, packaging requirements, durability, and power requirements. Use of the system will be through a simple control switch that will deploy and stow the sunscreen. The screen should also stow manually. It should also require zero maintenance, last 50,000 cycles, and be made of a material sturdy enough to withstand a light force of a moderately sized object tossed at the sunscreen. The screen should block out at least 10% of the light to match the competition.

Major concepts for deployment included linkages driven by SMA, direct use of the SMA to deploy the screen, and time ratcheted methods to deploy the sunscreen. The concepts were downselected in three steps. First, feasibility of the various concepts was tested. The remaining concepts were put into a selection matrix and ranked against each other. Finally, the best of these were weighted against each other using a concept scoring matrix. This process was also undertaken for stowing and latching the screen.

The selected design uses SMA to drive a bar connected to a four bar linkage that deploys the screen, which latches to the roof of the car. To stow the screen, SMA will push into the latch again and a spring will guide the mechanism downwards. Major challenges for this design included designing parallel motion for the mechanism, designing for the spring-assisted return motion, dimensioning the various parts and selecting the parts' materials, and analyzing the various failure methods for the design.

The prototype was built from aluminum and mounted on an aluminum plate, which was in turn mounted on a wooden frame to represent the angle of deployment. The SMA successfully deployed the linkage and latched in. The prototype met the power constraint, and can be manually stowed. The final design, being made of more lightweight materials than the prototype, will also meet the weight requirement. The prototype has shortcomings in meeting the volume constraint, meeting the stroke length, and returning without manual stowing. Further design improvements need to be made on the spring-return system to allow for stowing, and to the SMA spool that is connected to the center bar in order to meet the stroke. Meeting the volume constraint will be very challenging while using SMA due to the difficulties in packaging the wire.